Running head: ANALYSIS OF THE OPTIFILL II AUTOMATED SYSTEM

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OptiFill II Automated Prescription Bottle Filler System

Post-implementation Analysis

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14. ABSTRACT

Since 1995, the Naval Hospital Pensacola has been experiencing a decline in its number of pharmacists and pharmacy technicians. Along with this decline in pharmacy personnel, Naval Hospital Pensacola has seen an increase in its pharmacy workload. In an attempt to accommodate this increase in work, three processes were implemented. These processes have alleviated some of the wait times experienced by patients, but have not reduced the increased burden placed upon pharmacy personnel. In an attempt to remedy this, the Naval Hospital Pensacola decided, in 1998, to lease the OptiFill II automated prescription bottle filler system. This project evaluated the impact on the quality of care delivered by the OptiFill II system. This was done by measuring the pharmacy dispensing error rate for a three month period before and after implementation of the system. The decrease in the pharmacy dispensing error rate was found to be highly significant ($p < .01$, $df = 1$). This project also performed a cost benefit analysis of the system. While there was no cost benefit found, the author does recommend continuing use of the OptiFill II system based upon a significant increase in the quality of care delivered.

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Table of Contents

Executive Summary

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Introduction

In April 1995, the number of military pharmacy technicians at Naval Hospital Pensacola numbered 24. The number of military technicians has since been steadily decreasing until they reached their current number of 14 in June of 1998. Worsening the effect of this decrease in personnel is the fact that in January of 1996, the civilian personnel contract was renegotiated with a subsequent loss of seven personnel. The number of civilian personnel has since remained constant at 10. During this period, the pharmacy workload also increased from a monthly amount of 6000 prescriptions filled in April 1995 to 7000 in June of 1998. These reverse trends of decreasing staff and increasing workload placed an increased demand upon the pharmacy staff. Thus, three processes were implemented to try and alleviate this burden.

The shortage of staff was first addressed by the assignment of Programmed School Input (PSI) personnel to the pharmacy. These are personnel who have been selected to attend advanced training and are awaiting their class convening date. These personnel were trained on pharmacy processes and assisted in the filling of prescriptions. Pharmacists reviewed these prescriptions to ensure accuracy. These personnel are still being utilized by the pharmacy.

While the use of PSI personnel addressed the need for manpower, it may have also placed patients at a higher risk of medication errors. Also, since these personnel are temporary, the pharmacist is constantly tasked with training new personnel.

Even with these extra personnel, the pharmacy staff was still placed in the position of having to stand onboard 12 hour watches every other weekend in order to try and meet the demand of filling prescriptions. This tremendous workload raised the question of increased fatigue on the part of the staff posing a potential risk to patient care in the form of increased medication errors.

Another process implemented was that of only filling a prescription once a patient presents to the pharmacy. This process was implemented due to the fact that patients would have their provider submit their prescription to the pharmacy via the Composite Health Care System (CHCS) and then not pick up the prescription until much later that day if at all. The pharmacy staff then found themselves filling prescriptions for patients who were not there and delaying the delivery of medication to those patients who were waiting. While this process did not relieve the burden upon the staff, it did reduce the wait time of patients.

Finally, a satellite pharmacy refill site was opened in October 1998. This has had positive effects for both the

pharmacy and patients. First, it has decreased the congestion at the hospital pharmacy. Second, it has created a greater convenience for patients in that they may pick up their prescriptions while they shop at the Navy Exchange, which has a greater parking capacity than the Naval Hospital.

The use of the CHCS to send prescriptions electronically and the creation of the satellite pharmacy are two approaches to reducing patient wait times and congestion that many naval hospitals have implemented (Bayles, Hall, Hostettler, Gibson, & Woker, 1997). While successful at reducing patient wait times and congestion, these approaches have done nothing to decrease the need for more staff. To address this need, the Naval Hospital Pensacola decided in December 1997 that it would investigate the possibility of purchasing an automated refill system. Finally, in August 1998, it was decided to lease the OptiFill II automated system of prescription bottle filling.

OptiFill II Automated System

The OptiFill II automated refill system at Naval Hospital Pensacola functions as follows:

1) The patient places an order for the refill of his/her prescription. The Naval Hospital Pensacola has two methods of placing this order.

- The first method is the use of an automated telephone refill system that prompts the caller to enter his/her

prescription number. This system, "provide(s) patients ready access to refill information and eliminate(s) the need to manually transcribe it" (Bayles et al., 1997, p. 781).

- The second method is by dropping a refill request form at either a designated drop location or the pharmacy window.

2) The refill order is then entered into the CHCS either directly by the automated phone refill system or by a pharmacy technician.

3) The refill order information is downloaded from CHCS into the OptiFill II by the system operator.

4) A “tote”, which has a bar code that is scanned, is assigned to the individual patient. A copy of each prescription for the patient is printed and placed into the tote.

5) The OptiFill II system selects the appropriate size bottle (103cc or 197cc) for the prescription. (Note: If the prescription can not fit into a single bottle, the system splits the medication into the appropriate number of bottles and label them 1 of x, 2 of x, and so on up to 8 of 8.)

6) A bar coded label containing the patient information, drug name, dosage, instructions and prescribing doctor is printed and affixed to the bottle.

7) The labeled bottle is then conveyed to the appropriate filling zone and directed to the location where the drug will be dispensed.

8) The bottle is then transferred to the inspect station where a video image of the contents is taken and a childproof cap applied. (Note: If the system suspects that an error occurred in the filling of the prescription, e.g., incorrect weight of the medication or label information error, it will reject the prescription and reprocess the order.)

9) The completed prescription is then sent to the accumulator station. Here the prescription is placed in the next available sort lane in the station. The prescription waits here until all bottles for an order are complete and in the same lane, at which time the completed prescriptions for a particular patient are dropped into the assigned tote.

10) While the prescription filling process is occurring, the tote is traveling along an elliptical tract that carries it past the accumulator station. Once in front of the station, the tote is stopped and scanned. If all prescriptions for that patient are completed, the prescriptions are dropped into the tote and it continues to the next point. If the prescriptions are not completed, the tote is placed back into the loop awaiting the filling of all prescriptions.

11) Once all prescriptions for the patient are placed into the tote, it is allowed to leave the prescription filling loop and travels to the next point. At this point the tote is stopped and scanned once again. If all prescriptions for the

patient are completed, it is allowed to pass to the final inspection station. If the patient has a prescription that can not be completed by the system (e.g. ointments, liquids, etc.) it is diverted to the hand-pick station.

12) At the hand-pick station, a technician removes the labels and fills the prescriptions for all items not filled by the OptiFill II system. The tote is then placed back on the tract to continue to the final inspection station.

13) At the final inspection station, the tote is scanned. This produces a list of all prescriptions that should be in that tote. The inspector then scans the individual prescription bottle. This produces an image of the dispensed drug and a reference image of the drug. If the inspector agrees that the items match, he/she passes the item. The system then creates a database entry with the patient's name, drug, date, time, and final inspector (each inspector is given a logon ID and password) for record keeping purposes. (Baxter Healthcare Corporation, 1998).

Conditions Which Prompted the Study

As mentioned previously, in August 1998, the Naval Hospital Pensacola decided it would lease the OptiFill II automated prescription bottle filler system. This lease was for a period of two years at a cost of $288,456. The leasing period was set at two years because, "The Naval Hospital (did) not know if they

(would) have their own Pharmacy Department after two years due to military budget cuts. Therefore, they (were) reluctant to purchase the equipment ... since their future (was) unknown" (Naval Medical Logistics Command, 1998). Since the time of the original lease, the future of the Pharmacy Department has been secured and it will remain in place after the two-year lease period. This decision raised the question of the actual benefit of the system to the Naval Hospital Pensacola.

In order to determine the benefit, if any, to Naval Hospital Pensacola, the researcher asked the following questions:

1) Does the OptiFill II automated system reduce pharmacy dispensing errors? If so, does this equate to a higher quality of care delivered?

2) Is there a cost-benefit of leasing the OptiFill II system versus hiring additional pharmacy employees?

By the answering these questions, the researcher hoped to provide useful information to the Executive Steering Council to aid in their decision to either extend the lease agreement or abandon the system and seek other alternatives to their staffing dilemma.

Literature Review

Pharmacy Dispensing Error Rates

It would seem logical that increasing automation of the prescription filling process would decrease the number of pharmacy dispensing errors. However, in the literature review, while there are several articles addressing bedside medication errors, no research could be found comparing the pharmacy dispensing error rates before and after implementation of an automated pill-dispensing system. General, non-research articles were found, however, with statements such as that by Kristin Storey (1996) of The Detroit News, "Phred (**Ph**armacy **R**obot **E**lectronic **D**ispenser), ... has an error rate of just 1 in 300 million" (p. M1). This begs the question, what was the error rate prior to installation of Phred? Other articles, Robots Give Providers a Helping Hand (Gardner, 1992) and Pharmacies Gain Staff Time as New "Employee" Lends a Hand (Landis, 1993), cite 100% accuracy after implementation of an automated pharmacy system. Once again, though, no research is cited to evaluate this rate against the error rate prior to installation of these systems. Granted, the prior error rates were most likely higher, but would the research substantiate this assumption?

The only article found during the literature review that addresses the issue of a significant change in error rates is

that by Carol Ukens (1998). She states that after Ekcerd Corporation installed the ScriptPro 200 in its Georgia stores, "dispensing error rates ... dropped significantly, to less than 3%" (p. 2).

It appears that, as Naval Hospital Pensacola did, many facilities are purchasing/leasing pharmacy automation products without hard independent data demonstrating a significant decrease in the pharmacy dispensing error rate. As Darryl G. Glover (1997), PharmD, writes, "In general, all of the (automation) products are 100% accurate in medication selection and greater than 95% accurate in medication count (+/- 1 to 2 tablets), ***according to the vendors***" (emphasis added) (p. 355). He later states that in the two years that the OptiFill II has been installed at the Pharmaceutical Care Center (PCC) of the University of Illinois at Chicago, "there have been no errors in medication selection" (Glover, 1997, p. 357).

While the researcher does not mean to question the integrity of the vendors, it does seem that an independent evaluation of a product's pharmacy dispensing error rate would provide more valuable information to possible purchasers. Given the above, the lack of empirically validated error rates for an automated dispensing systems could be a significant factor in the assessment of the system’s impact on dispensing error rates.

Also related to the question of pharmacy dispensing error rates is that of the quality of care delivered. It was the researcher's goal to assess the impact on quality of care by measuring the pharmacy dispensing error rates before and after implementation of the OptiFill II automated system. According to Daniel H. van Leeuwen, RN, MPH, this is a valid measurement tool. As he states, "The focus on measuring error rates is important for improving quality within organizations because drug-related errors are an important cause of adverse events" (1994, p. 198). This is further confirmed by Barker and Allan (1995) when they state, "the Task Force on Medication Use of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) ... judged the medication error rate as the single most important indicator of the quality of the medication-use system" (p. 400).

Cost-benefit Analysis

The question of a cost-benefit analysis was also evaluated during the literature review. Unlike research regarding medication error rates, it appears that many facilities have performed a cost-benefit analysis prior to implementing an automated system. This is based upon the fact that several articles mention an estimated payback period. For example, Gardner (1992) states that Presbyterian University Hospital in

Pittsburgh; Duke University Medical Center in Durham, N.C.; University of Wisconsin Hospital in Madison; and University of Maryland Hospital in Baltimore, "estimate a payback time of 18 to 36 months" (p. 90).

According to Glover (1997), any "analysis should examine the fixed supply and labor costs (salary, benefits, vacation, sick leave, and break time) under the two options as well as estimate the potential increase in revenue resulting from the provision of new services" (p. 354). Wise, Bostrom, Crosier, White and Caldwell (1996) also recommend evaluating the number of medication orders filled/refilled each day, total technician/pharmacist time and medication dose charge capture per day in their cost-benefit analysis.

Methods and Procedures

Pharmacy Dispensing Error Rates

A retrospective analysis was conducted using the refill dispensing errors as reported by the Naval Hospital Pensacola Pharmacy Department to the Joint Commission of Accreditation of Healthcare Organizations (JCAHO) for the period from May 1998 to May 1999. (See table 1)

Table 1 Naval Hospital Pensacola Pharmacy Refill Dispensing Errors for Period May 1998 - May 1999

Month	Total Refills Dispensed	Refill Dispensing Errors	Error Rate (%)
May 98	19,911	8	.04
Jun 98	19,043	7	.04
Jul 98	19,129	15	.08
Aug 98	19,027	5	.03
Sep 98	17,089	4	.02
Oct 98	19,310	9	.05
Nov 98 *	19,264	6	.03
Dec 98 *	19,204	2	.01
Jan 99 *	19,291	2	.01
Feb 99	18,104	0	.00
Mar 99	20,378	4	.02
Apr 99	19,310	1	.01
May 99	18,344	5	.03
Total	247,404	68	.03

* Months discarded from study due to filling of refill prescriptions by both staff and OptiFill II system at this time.

A period of three months pre and post implementation of the OptiFill II system was used with the months of November 1998 through January 1999 being discarded. These months were discarded because it was during this period that the OptiFill II system was being installed and tested. During this time, both the technicians and the OptiFill II system filled prescriptions.

It was not until February 1999, that the process of filling refill prescriptions was accomplished solely through the use of the OptiFill II system. The research period did not include the month of Jul 98 for fear that the abnormally high error rate for Jul 98 may skew the results. To keep the periods before and after implementation equal, the fourth month after implementation, May 99, was also discarded.

For the purposes of this research, the names of patients, pharmacists and pharmacy technicians were neither needed nor used and are not included in this report.

The alternate hypothesis for this analysis is that the number of pharmacy dispensing errors is related to implementation of the OptiFill II automated prescription bottle filler system. The null hypothesis is that the number of pharmacy dispensing errors is not related to implementation of the OptiFill II automated prescription bottle filler system.

The independent variable is the OptiFill II system. It is a dichotomous variable, nominally coded as 1 for OptiFill II system present and 0 for all others.

The dependent variable is pharmacy dispensing errors. This, too, is a dichotomous variable, nominally coded as 1 for an error and 0 for all others.

The inferential statistical analysis used was the x^2 test for goodness of fit. Since the sample size was greater than 40, and in accord with the recommendations of Cooper and Emory (1995), the Yates' correction for continuity was applied.

Cost-benefit Analysis

As mentioned previously, the Naval Hospital Pensacola decided it would lease the OptiFill II automated prescription bottle filler system for a period of two years. This was at a total cost of $288,456. The Naval Hospital Pensacola also held an option to purchase the OptiFill II after the initial two-year lease period. The additional cost to purchase the system would be $322,759 for a total cost of $611,215 after a two-year period. If a maintenance contract were also desired to cover the additional three years, this would come at a price of $50,000 per year, raising the total cost for five years to $761,215.

In reply to Naval Hospital Pensacola solicitations for proposals from manufacturers, the Baxter Corporation submitted that the OptiFill II was "designed to process 2,000 prescriptions per 8 hour shift" (Baxter Healthcare Corporation, 1998, p. 11).

In a direct observation of Naval Hospital Pensacola pharmacy technicians over a five day period at various times, it was determined that the mean time to fill a prescription, excluding transcription and verification time, was 1 minute 2 seconds. This extrapolates to 464.52 prescriptions filled per pharmacy technician per eight-hour shift. Transcription and verification times were excluded because this must be accomplished regardless of whether or not the OptiFill II system is in place.

The mean salary of a pharmacy technician at Naval Hospital Pensacola is $33,316. This salary is based upon the salaries of civilian contract and government civil service technicians. Based upon a 2080-hour work year, this equates to a salary of $16.02 per hour, or a cost of $128.16 per eight-hour day.

The OptiFill II system is currently used only during a normal eight-hour workday, excluding weekends and holidays, due to a lack of personnel trained in the operation of the system. (Note: Trained personnel are defined as those individuals capable of refilling the label rollers, refilling the bottle

hoppers, downloading required information from the CHCS, reloading medication cartridges and trouble-shooting any other problems which may occur with the OptiFill II system.)

During the first quarter of calendar year 1999, the Pharmacy Department of Naval Hospital Pensacola processed 76,136 prescriptions. The Pharmacy Department at the Branch Medical Clinic (BMC) at Naval Air Station (NAS) Whiting Field processed 11,024 refill prescriptions over this same four month period. (See table 2)

It was based upon these facts that a cost-benefit analysis was performed.

Table 2 Branch Medical Clinic Naval Air Station Whiting Field Refill Prescriptions Filled for Period February 1999 - May 1999

Month	Total Refills Dispensed
Feb 99	2707
Mar 99	2880
Apr 99	2523
May 99	2717
Total	10827

The alternate hypothesis is that use of the OptiFill II automated bottle filler system has resulted in a cost savings to the Naval Hospital Pensacola. The null hypothesis is that use of the OptiFill II automated bottle filler system has not resulted in a cost savings to the Naval Hospital Pensacola.

Once again, the names of pharmacists or pharmacy technicians were neither needed nor used and are not included in this report.

Results

Pharmacy Dispensing Error Rates

The expected finding from this research was that the pharmacy dispensing error rate would decrease significantly after implementation of the OptiFill II automated bottle filler system, thus supporting the alternate hypothesis (see Table 3). The results of the x^2 test for goodness of fit, support this supposition with a highly significant result ($p < .01$, $df = 1$).

Table 3 Pre/Post Deployment Analysis Results of the OptiFill II Automated Prescription Bottle Filler System

	Total Refills	Errors	Error Mean	SDM
Pre-deployment	55,426	18	.0003	.02
Post-deployment	57,792	5	.0001	.01

Cost-benefit Analysis

Using the previously stated facts, a cost-benefit analysis was performed and resulted in the following calculations:

1) The total number of refill prescriptions filled by the OptiFill II in the four month period from February 1999 to May 1999 was 76,136. This equates to a mean of 895.72 prescriptions per day, excluding weekends and holidays.

2) Based upon the aforementioned pharmacy technician rate of 464.52 prescriptions per day, it would take 1.93 Naval Hospital Pensacola pharmacy technicians to fill those same 895.72 prescriptions.

3) The cost of two (1.93 rounded up) pharmacy technicians at an average salary of $33,316 per year would be $22,210.67 for the same four-month period.

4) The cost of the OptiFill II system for a four-month period equals $48,076 (including maintenance costs).

If, however, the Pharmacy Department at the Naval Hospital Pensacola filled the refill prescriptions for BMC NAS Whiting Field (a nearby clinic) during this period, the total number of refills would have been 86,963. This equates to a mean of 1023.09 prescriptions per day.

At the aforementioned prescription fill rate for a pharmacy technician, it would require 2.20 technicians to fill these

prescriptions. This would be at a cost of $33,316 for three technicians (rounding up the 2.2 technicians).

Based upon the mean salary of a pharmacy technician, the daily prescription fill rate, and the cost of the OptiFill II system, it is calculated that the break-even point for use of the OptiFill II system is 2010.95 refill prescriptions per day. This equates to 4.33 technicians. However, because anything above 4.0 would require the hiring of a fifth technician, once the volume of refill prescriptions exceeds 1858, a cost savings will be seen.

Discussion

Pharmacy Dispensing Error Rates

The results of the x^2 statistical analysis ($p < .01$, $df = 1$) provide strong evidence that the implementation of the OptiFill II automated bottle filler impacts on the pharmacy dispensing error rate at Naval Hospital Pensacola. Thus, the null hypothesis is rejected and the alternate hypothesis is accepted. Based upon the supposition that medication error rates are a valid measure of the quality of care delivered, it may also be stated that implementation of the OptiFill II automated bottle filler system positively impacts on the quality of care delivered at Naval Hospital Pensacola.

Cost-benefit Analysis

The cost of leasing the OptiFill II automated bottle filler system for the four-month period was $48,076. The cost of hiring additional technicians for the volume of work over that same four-month period would have been $22,210.67. Even if the refill prescriptions of nearby BMC NAS Whiting Field for the same four month period were filled at Naval Hospital Pensacola, the cost of hiring additional technicians would have been $33,316. Based upon these calculations, the researcher has determined that a cost-benefit does not exist for the Naval Hospital Pensacola.

These calculations are a result of the fact that the Naval Hospital Pensacola is not utilizing the OptiFill II system to its full capability. In order to realize a cost-benefit, the volume of prescriptions filled by the OptiFill II system must exceed 1858 daily. This can be accomplished by the inclusion of new prescriptions into the prescriptions that are filled by the OptiFill II system. Another alternative may be to include the refill prescriptions of other outlying branch medical clinics. To this end, the Pharmacy Department at Naval Hospital Pensacola is examining the feasibility of incorporating the refill prescriptions from BMC Meridian, MS and Millington, TN.

Other Areas of Concern

Although this project did not find a cost-benefit from the implementation of the OptiFill II system, there are other areas that may be impacted by the use of the OptiFill II system. Examples of such areas are patient wait times, staff morale, and pharmacist-patient interaction times. Future research may want to examine these areas.

Conclusion and Recommendations

The goal of this research project was to determine if the OptiFill II automated bottle filler system had a positive impact on the Pharmacy Department of Naval Hospital Pensacola, Florida. The research revealed a significant decrease ($p < .01$) in the number of pharmacy dispensing errors subsequent to the implementation of the OptiFill II system. This was then used as a measurement of the quality of care delivered. This result suggests that the OptiFill II system resulted in an increase in the quality of care delivered at Naval Hospital Pensacola. There may be other factors involved, however. Also, this researcher cautions against over-reliance on the OptiFill II system causing complacency in the pharmacy staff.

A cost-benefit analysis was also performed. The results of this analysis did not indicate a cost-savings to the Naval Hospital Pensacola. This was attributed to the fact that the OptiFill II system is currently not being used to it full

capability. To rectify this, and realize the true cost savings of the system, the researcher recommends the incorporation of the refill prescriptions of any available branch medical clinics in the area. The researcher also recommends that the Naval Hospital Pensacola investigate the feasibility of incorporating new prescriptions into the OptiFill II system.

Although the OptiFill II system does not currently reflect a cost-savings to the Naval Hospital Pensacola, the researcher believes that the highly significant decrease in the pharmacy dispensing error rate, and resulting increase in the quality of care delivered, is worth this increase in cost. Additionally, the researcher recommends that any future research include a cost-effectiveness analysis of the OptiFill II system.

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